Bureau Of Mines

Brian Lett – Director of Mines

Vincennes University
Technology Building
1002 North First Street
Vincennes, IN 47591
(812) 888-4514

SHOT FIRER'S STUDY GUIDE

QUALIFICATIONS

- **Must hold an Indiana Miners license.**
- **Must have one year mining experience.**
- **Must have been properly trained in a course approved by the director in the safe use and handling of explosives.**
    - **Must prove to the board (by written, oral, and demonstration): – Applicant has a working knowledge of:**
    - **Proper handling and use of explosives and blasting devices and the dangers connected there with.**
    - **Nature and properties of poisonous, noxious, and explosive gases and methods for their detection.**
        - **Thorough knowledge of the coal mining laws in this state pertaining to explosives and blasting devices.**
        - **Thorough knowledge of requirements of the coal mining laws pertaining to explosives and blasting devices in the Federal Code of Regulations Title 30.**
        - **Receive a grade of seventy-five percent (75%) or higher on the examination.**
- **An applicant for examination must pay the Bureau of Mines an examination fee of twenty-five dollars ($25.00).**

Definitions

Approval. A document issued by MSHA which states that an explosive or explosive unit has met the requirements of this part and which authorizes an approval marking identifying the explosive or explosive unit as approved as permissible.

Blasting off the solid. Blasting the working face without providing a second free face by cutting, shearing or other method before blasting.

Instantaneous detonator. An electric detonator that fires within 6 milliseconds after application of the firing current.

Laminated partition. A partition composed of the following material and minimum nominal dimensions: 1/2-inch thick plywood, 1/2-inch thick

gypsum wall board, 1/8-inch thick low carbon steel and 1/4-inch thick plywood, bonded together in that order.

Opener hole. The first hole or holes fired in a round blasted off the solid to create an additional free face.

Permissible blasting unit. A device that has been approved by MSHA and that is used for firing electric detonators.

Permissible explosive. Any substance, compound or mixture which is approved by MSHA and whose primary purpose is to function by explosion.

Round. A group of boreholes fired or intended to be fired in a continuous sequence with one application of the firing current.

Sheathed explosive unit. A device consisting of an approved or permissible explosive covered by a sheath encased in a sealed covering and designed to be fired outside the confines of a borehole.

Short-delay electric detonator. An electric detonator with a designated delay period of 25 to 1,000 milliseconds.

Preparation before blasting

1. **All non-battery-powered electric equipment, including cables, located within 50 feet from boreholes to be loaded with explosives or the sites where sheathed explosive units are to be placed and fired shall be deenergized or removed to at least 50 feet from these locations before priming of explosives. Battery-powered equipment shall be removed to at least 50 feet from these locations before priming of explosives.**
2. **As an alternative to paragraph (a)(1) of this section, electric equipment, including cables, need not be deenergized or removed if located at least 25 feet from these locations provided stray current tests conducted prior to priming the explosives detect stray currents of 0.05 ampere or less through a 1-ohm resistor.**
    a. **Tests shall be made at floor locations on the perimeter, on energized equipment frames and on repaired areas of energized**

cables within the area between 25 to 50 feet from the locations where the explosives are to be primed.

b. Tests shall be conducted using a blasting multimeter or other instrument specifically designed for such use.

3. The blasting cable or detonator circuitry shall not come in contact with energized electric equipment, including cables.

a. (b) Before loading boreholes with explosives, each borehole shall be cleared, and its depth and direction determined.

b. (c) No borehole drilled beyond the depth of cut coal shall be loaded with explosives unless that portion of the borehole deeper than the cut is tamped with noncombustible material.

c. (d) When two working faces are approaching each other, cutting, drilling and blasting shall be done at only one working face at a time if the two faces are within 25 feet of each other.

Section 1

- **Explosives and blasting equipment:**
  - **Only permissible explosives approved sheathed explosive units, and permissible blasting units shall be taken or used underground.**
  - **Black blasting powder, aluminum-cased detonators, aluminum alloy-cased detonators, detonators with aluminum leg wires, and safety fuses shall not be taken or used underground.**
  - **Explosives shall be fired only with a permissible blasting unit used in a manner consistent with its approval. Blasting units approved by MSHA that have approval labels specifying use with short-delay detonators with delay periods between 25-500 milliseconds are accepted to fire short-delay detonators up to 1,000 milliseconds.**
  - **Permissible explosives and sheathed explosive units shall not be used underground when they are below the minimum product firing temperature specified by the approval. Explosives previously approved which do not specify a minimum firing temperature are permissible for use so long as the present approval is maintained.**
  - **Electric detonators shall be compatible with the blasting unit and have sufficient strength to initiate the explosives being used.**
- **All explosives used underground in coal mines shall be used as follows:**
  - **Fired only with electric detonators of proper length.**

- **Fired with permissible shot-firing units or fired by other devices permitted by the United States Mine Safety and Health Administration, unless firing is done from the surface when all men are out of the mine. Shots may be fired with a non-permissible shot-firing unit with persons in the mine but not in by the last open crosscut provided and application has been filed with and approved by the director. Such application must include the following:**
  - **The name and address of the mine.**
  - **The active workings in the mine in which such units will be used and the approximate number of shots to be fired.**
  - **The period during which such units are to be used.**
  - **The nature of the development or construction for which they will be used, e.g., overcasts, undercasts, track grading, roof brushing, or boomholes.**

- **A plan, proposed by the operator, designed to protect miners in the mine from the hazard of methane and other explosive gases during each multiple each multiple shot,**

  e.g., changes in the mine ventilation system, provisions for auxiliary ventilation and any other safeguards necessary to minimize such hazards.

- **A statement of the specific hazards anticipated by the operator in blasting for overcasts, undercasts, track grading, brushing of roof, boom holes, or other unusual blasting situations such as coal beds of abnormal thickness.**
- **The method to be employed in the use of non-permissible shot-firing units to avoid the dangers anticipated during development or construction which will ensure the protection of life and the prevention of injuries to the miners exposed to such underground blastings.**

Section 2

- **Separate surface magazines shall be provided for the storage of explosives, detonators, and blasting heater elements.**
- **Surface magazines for storing and distributing explosives in amounts exceeding one hundred twenty-five (125) pounds shall be as follows:**

- **Reasonably bulletproof and constructed of incombustible material or covered with fire-resistive material. The roofs of magazines so located that it is impossible to fire bullets directly through the roof from the ground need not be bulletproof, but where it is possible to fire bullets directly through them, roofs shall be made bullet resistant by material construction, or by a ceiling that forms a tray containing not less than four (4) inch thickness of sand, or by other methods.**
- **Provided with doors constructed of three-eight (3/8) inch steel plate lined with a two (2) inch thickness of wood, or the equivalent.**
- **Provided with dry floors made of wood or other non-sparking material and have no metal exposed inside the magazine**
- **Provided with suitable warning signs so located that a bullet passing directly through the face of the sign will not strike the magazine.**
- **Provided with properly screened ventilators.**
- **Equipped with no openings except for the entrance and ventilation.**
- **Kept locked securely when unattended.**

- **Surface magazines for storing detonators need not be bullet proof, but they shall be in accordance with other provisions for storing explosives.**
- **Explosives in amounts of one hundred twenty-five (125) pounds or less or five thousand (5000) detonators or less shall be stored in accordance with preceding standards or in separate locked box-type magazines. Box-type magazines may also be used as distributing magazines when quantities do not exceed those mentioned. Box type magazines shall be constructed strongly of two (2) inch hardwood or the equivalent. Metal magazines shall be lined with non-sparking material. No magazine shall be placed in a building containing oil, grease, gasoline, wastepaper, or other highly flammable material, nor shall a magazine be placed less than twenty (20) feet from a stove, furnace, open flame, or flame.**
- **The location of magazines shall not be less than two hundred (200) feet from any mine opening, occupied building, or public road. Where compliance with this provision is not practical, the magazine shall be effectively barricaded.**
- **The supply kept in distribution magazines shall be limited to approximately one (1) day's requirement, and such supplies of explosives and detonators may be distributed from the same magazine, if separated**

by at least four (4) inch substantially fastened hardwood partition or equivalent.

- **The area surrounding magazines for no less than twenty-five (25) feet in all directions shall be kept free of rubbish, dry grass, or other materials of a combustible nature.**
- **If the explosives magazine is illuminated electrically, the lamps shall be of vapor-proof type, installed and wired so as to present minimum fire and contact hazards.**
- **Only nonmetallic tools shall be used for opening wooden containers. Extraneous materials shall not be stored in an explosive, detonator, or blasting heater element magazine.**
- **Smoking, carrying smoker's articles, or open flame shall be prohibited in or near any magazine.**
- **Cardox may not be used in an underground mine.**

Section 3

Explosives or detonators carried anywhere underground by anyone shall be in containers constructed substantially of nonconductive material, maintained in good condition, and kept closed. (1) They shall be enclosed in separate, substantially constructed containers made of nonconductive material, with no metal or other conductive materials exposed inside. Each container of explosives and of detonators shall be indelibly marked with a readily visible warning identifying the contents.

When explosives or detonators are transported underground in cars moved by means of a locomotive or rope, or in shuttle cars, they shall be in substantial covered cars or in special substantial covered containers used specifically for transporting detonators or explosives. In addition, the following provisions apply

- **The cars or vehicles shall be marked with warnings to identify the contents as explosive.**
- **The warnings shall be readily visible to miners approaching from any direction and in indelible letters;**
- **Explosives and detonators shall be transported either in separate cars or vehicles, or if in the same cars or vehicles as follows:**
  - **Class A and Class C detonators in quantities greater than 1,000 shall be kept in the original containers as shipped from the**

manufacturer and separated from explosives by a hardwood partition at least 4 inches thick, a laminated partition or equivalent; and

- **Class A and Class C detonators in quantities of no more than 1,000 shall be separated from explosives by a hardwood partition at least 4 inches thick, a laminated partition or equivalent.**

- **The bodies and covers of such cars and containers shall be constructed or lined with nonconductive material.**
- **If explosives and detonators are hauled in the same explosive car or in the same special container, they shall be separated by at least a four (4) inch substantially fastened hardwood partition or the equivalent.**
- **Explosives, detonators, or other explosive items shall not be transported on the same trip with men.**
- **When explosives or detonators are transported in special cars or containers in cars, the cars or vehicles shall be marked with warnings to identify the contents as explosive. The warnings shall be readily visible to miners approaching from any direction and in indelible letters; they shall be hauled in special trips not connected to any other trip. However, additional cars as needed may be used to lower a rope trip, or to haul supplies including timbers if the materials transported do not project above the top or the car. Exposed highly flammable materials such as oil or grease shall not be hauled on the same trip with explosives.**
- **Explosives or detonators shall not be hauled into or out of a mine within five (5) minutes preceding or following a man-trip or any other trip and Cars containing explosives or detonators shall be separated from the locomotives by at least one car that is empty or that contains noncombustible materials.**
- **Explosives and detonators shall be transported underground by belt conveyor only under the following conditions;**
- **Containers of explosives shall be separated of detonators by at least 50 feet; from containers**
- **At least 6 inches of clearance shall be maintained between the top of any container of explosives or container of detonators and the mine roof or other obstruction;**
- **Except when persons are riding the belt to accompany explosives or detonators, a person shall be at each transfer point between belts and at the unloading location; and**

- **Conveyor belts shall be stopped before explosives or detonators are loaded or unloaded**
- **When explosives and detonators are transported by hand they shall be carried in separate, nonconductive, closed containers.**
- **In the original and unopened case, in special closed cases constructed of nonconductive material, or in suitable individual containers.**
- **Clearance requirements shall be the same as those for transporting men on belts.**
- **Suitable loading and unloading stations shall be provided.**
- **Stop controls shall be provided at loading and unloading points, and an attendant shall supervise the loading and unloading of explosives and detonators. ○ Neither explosives nor detonators shall be transported on flight or shaking conveyors, scrapers, mechanical loading machines, locomotives, cutting machines, drill trucks, or any self-propelled mobile equipment. However, this does not prohibit the transportation of explosives or detonators in special closed containers.**

Section 4

When supplies of explosives and detonators for use in one or more sections are stored underground, and (Only explosives and detonators shall be kept in underground magazines), they shall be kept in section boxes or magazines of substantial construction with no metal exposed on the inside, located at least twenty-five (25) feet from roadways and any electric current, and in a reasonably dry, well rock dusted location protected from falls of roof.

- **When explosives or detonators are stored in the section, and they shall be kept preferably in separate boxes or magazines not less than five (5) feet apart; if kept in the same box or magazine, they shall be separated by at least a four (4) inch substantially fastened hardwood partition or the equivalent. Not more than a forty-eight (48) hour supply of explosives or detonators shall be stored underground in such boxes or magazines.**
- **Explosives and detonators stored near the working faces shall be in separate closed containers and shall be in a location out of line of blast not less than fifty (50) feet from the face and fifteen (15) feet from any pipeline, power line, rail or conveyor; except that if kept in niches in the rib, the distance from pipelines, power lines, rail or conveyors shall be**

five (5) feet. Such explosives and detonators, when stored, shall be separated by a distance of at least five (5) feet.

- **The quantity of explosives outside a magazine for use in a working section or other area where blasting is to be performed**
  - **shall Not exceed 100 pounds**
  - **or Not exceed the amount necessary to blast one round when more than 100 pounds of explosives is required.**

Explosives and detonators outside a magazine that are not being transported or prepared for loading boreholes shall be kept in closed separate containers made of nonconductive material with no metal or other conductive material exposed inside and the containers shall be—

- **At least 15 feet from any source of electric current;**
- **Out of the direct line of the forces from blasting;**
- **In a location to prevent damage by mobile equipment; and Kept as dry as practicable.**

Explosives and detonators not used during the shift shall be returned to a magazine by the end of the shift.

Section 5

Where coal is cut, shots shall not be fired if the blast hole is drilled beyond the limits of the cut.

- **Boreholes shall be cleaned, and they shall be checked by the shot-firer to see that they are placed properly and are of correct depth, in relation to the cut before being charged. Improperly drilled holes shall not be charged.**
- **All blasting charges in coal shall have a burden of at least eighteen (18) inches in all directions if the height of the coal permits.**
- **Boreholes shall be stemmed with at least twenty-four (24) inches of incombustible material, or at least one-half (1/2) of the length of the hole shall be stemmed if the hole is less than four (4) feet in depth, unless other permissible stemming devices or methods are used.**
- **Shots shall not be fired in any place where methane can be detected with a methane detector approved by the United States Mine Safety and Health Administration when tested at a point not less than twelve (12) inches from the roof, face, and rib. Immediately before shots are fired, the**

methane concentration in a working place or any other area where blasting is to be performed, shall be determined by a person qualified to test for methane.

- **Charges exceeding one and one half (1 ½) pounds, but not exceeding three (3) pounds, shall be used only if boreholes are six (6) feet or more in depth, the explosives are charged in a continuous train, with no cartridges deliberately deformed or crushed, with all cartridges in contact with each other, and with the end cartridge touching the back of the hole and the stemming respectively, and Class A or Class B permissible explosives are used. However, the three (3) pound limit does not apply to solid rock work.**
- **Boreholes shall not be charged while any other work is being done at the face, and the shot or shots shall be fired before any other work is done in the zone of danger from blasting, except that which is necessary to safeguard the employees.**
- **Only non-metallic tamping bars shall be used for charging and tamping boreholes. This does not prohibit the use of a nonmetallic tamping bar with a non-sparking metallic scraper on one end.**
- **The leg wires of electric detonators shall be kept shunted until ready to connect to the firing cable.**
- **Shots shall not be fired from the power or signal circuit while men are in the mine.**

The roof and ribs of working places shall be tested before and after firing each shot or group of multiple shots.

Ample warning shall be given before shots are fired and care shall be taken to ascertain that all persons are in the clear. Men shall be removed from adjoining working places when there is danger of a shot blowing

- **through.**
- **Shots shall be prepared and fired by certified shot firers.**

A separate instantaneous detonator shall be used to fire each sheathed explosive unit.

- **Sheathed explosive units shall be primed and placed in position for firing only by a qualified person or a person working in the presence of and under the direction of a qualified person. To prime a sheathed explosive unit, the entire detonator shall be inserted into the detonator well of the unit and be held securely in place.**

- **Sheathed explosive units shall not be primed until immediately before the units are placed where they are to be fired. A sheathed explosive unit shall not be primed if it is damaged or deteriorated.**
- **Except in anthracite mines, rock dust shall be applied to the roof, ribs and floor within a 40-foot radius of the location where the sheathed explosive units are to be fired.**
- **No more than three sheathed explosive units shall be fired at one time.**
- **No sheathed explosive unit shall be fired in contact with another sheathed explosive unit.**

Section 6 Blasting Circuits

- **Blasting circuits shall be protected from sources of stray electric current.**
- **Detonators made by different manufacturers shall not be combined in the same blasting circuit.**
- **Detonator leg wires shall be shunted until connected into the blasting circuit.**
- **Blasting cables shall be**
  - **(1) Well insulated, copper wire of a diameter not smaller than 18gauge; and**
  - **(2) Long enough to permit the round to be fired from a safe location that is around at least one corner from the blasting area.**

Blasting cables shall be shunted until immediately before firing, except when testing for circuit continuity.

Wire used between the blasting cable and detonator circuitry shall-

(1) Be undamaged;

(2) Be well insulated;

(3) Have a resistance no greater than 20-gauge copper wire; and

(4) Be not more than 30 feet long.

Each wire connection in a blasting circuit shall be

(1) Properly spliced; and

(2) Separated from other connections in the circuit to prevent accidental contact and arcing.

- **Uninsulated connections in each blasting circuit shall be kept out of water and shall not contact the coal, roof, ribs, or floor.**

- **When 20 or fewer boreholes are fired in a round, the blasting circuit shall be wired in a single series.**
- **Immediately prior to firing, all blasting circuits shall be tested for continuity and resistance using a blasting galvanometer or other instrument specifically designed for testing blasting circuits. =**

Section 7

- **After blasting, the blasting area shall not be entered until it is clear of smoke and dust.**
- **Immediately after the blasting area has cleared, a qualified person or a person working in the presence of and under the direction of a qualified person, shall examine the area for misfires, methane and other hazardous conditions**
- **Where misfires occur with electric detonators, a waiting period of at least five (5) minutes shall elapse before anyone returns to the shot. After such failures the blasting cable shall be disconnected from the source of power and the battery ends short-circuited before electric connections are examined.**
- **Explosives shall be removed by firing a separate charge at least two (2) feet away from, and parallel to, the misfired charge or by washing the stemming and the charge from the borehole with water, or by inserting and firing a new primer after the stemming has been washed out. Misfires shall be removed promptly and before any other work is done in such place.**

A very careful search of the working place, and, if necessary, of the coal after it reaches the tipple shall be made after blasting a misfired hole, to recover and explosive that was not detonated.

- **The handling of a misfired shot shall be done by a certified shot-fire. When a misfire cannot be disposed of— ○ A qualified person shall post each accessible entrance to the area affected by the hazard of the misfire with a warning at a conspicuous location to prohibit entry; and**
  ○ The misfire shall be immediately reported to mine management.

Section 8

- **When compressed air is used for blasting or breaking down the coal, the following shall apply:**
  - **Air lines shall be tested to withstand an approximate pressure of twenty thousand (20,000) pounds per square inch.**
  - **Air lines shall be grounded at the compressor and, if possible, at the low-resistance ground connections along the lines, such as a borehole casing. They shall not be connected in any way to tracks, water lines, or other electric power return conductors and shall be suitably insulated where they cross electric wires or underneath track.**
  - **Shut-off valves shall be installed everyone thousand (1000) feet in all compressed-air lines and in all branch lines at a point near the main lines.**
  - **Compressed-air blasting lines shall be protected at places where equipment passes over, under, or adjacent to them.**
  - **Steel, copper, or other lines shall not be handled or repaired when air pressure is in the line.**
  - **Air lines shall be examined periodically for kinks or other weaknesses and replaced immediately when defects are found.**
  - **Tubing shall be coiled and uncoiled properly. The part of the tubing that is affected by frequent coiling and uncoiling shall be renewed periodically.**
  - **Blow-down valves shall not be less than forty-five (45) feet from the face and shall be around a right angle.**
  - **Holes for compressed-air tubes shall be within the limits of the cut, and compressed –air devices shall not be used in improperly drilled holes.**
  - **When blow-down valves are open to discharge the tube, they shall remain open until time to place the tube in the next borehole.**
  - **After breaking down the coal in any one place, the tube shall be disconnected at once from the air line and not reconnected until ready to be used in the next place.**
  - **When a differential pressure-type tube fails to discharge, the line leading to the tube shall be disconnected at the blow-down valve, and the tube shall be dragged by means of the line to an inactive**

place, marked with warning signs, and left one (1) hour before any repair work is done thereon.

- **All persons shall be removed from adjoining working places where there is danger of breaking through and shall be at a safe distance around a right angle while coal breaking is in progress.**
- **Breaking coal with compressed air shall be done by certified shotfirers.**

	Hydrogen Sulfide	Methane	Carbon Dioxide	Nitrogen	Oxygen	Carbon Monoxide	Hydrogen
Origin	Rarely found old pipelines in poorly ventilated areas	Occluded in Coal and decomposition of vegetation in water	Complete combustion Small quantity found naturally in air	Found naturally in air	Found naturally in air	Incomplete combustion Mine fires & explosions Blasting	Charging of batteries, mine fires, explosions
Chemical Symbol	H_2S	CH_4	CO_2	N_2	O_2	CO	H_2
Explosive Range	4.3 - 46%	5 - 15%	None	None	None	12.5 - 73%	4.0-74%
Effect on Life	.07% causes death in one hour. Destroys olfactory nerves	Death by suffocation	Death by suffocation	Death by suffocation	Necessary for life	.10% in air causes complete collapse Occludes oxygen from the blood	Inert
Detection	Multi-gas detector Odor Chemical analysis	Multi-gas detector Chemical analysis	Chemical analysis	Chemical analysis Multi-gas detector	Chemical analysis Multi-gas detector	Chemical analysis Multi-gas detector	Chemical analysis Multi-gas detector
Specific Gravity	1.191	0.555	1.5291	0.967	1.105	0.967	0.07
Ignition Temperature	700 degrees	1100 - 1380 Degrees	None	None	None	1100 degrees	935 degrees